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The conference **Frontiers in Human Information Processing** goal was to synthesize the state of cognitive theory with focus on the formal, computational, and mathematical approaches that unify the areas of vision, attention, and memory. The conference also highlights several key applications of these approaches in medicine, engineering, and education.

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Frontiers in Human Information Processing Conference Final Report

AFOSR GRANT # FA9550-07-1-0346

The AFOSR Grant # FA9550-07-1-0346 provided partial support for the Conference: **Frontiers in Human Information Processing – Vision, Attention, Memory, and Applications: A Tribute to George Sperling**, a Festschrift. We are grateful to the AFOSR for their contributions to making this a fascinating and successful conference.

Summary: A Festschrift Conference in honor of UC Irvine Distinguished Professor George Sperling, was held in Irvine, California at The University of California, Irvine, on July 28, 2007 to July 29, 2007. The Conference was designed to recognize Professor Sperling's transformational contributions to our understanding of vision, memory, attention, and applications. The goal of the conference was to synthesize the state of cognitive theory with focus on the formal, computational, and mathematical approaches that unify the areas of vision, attention, and memory. The conference also highlights several key applications of these approaches in medicine, engineering, and education.

Conference Organizers: Professors Barbara Anne Doshier (University of California, Irvine), Charles Chubb (University of California, Irvine), Zhong-Lin Lu (University of Southern California), & Richard Shiffrin (Indiana University).

Sponsors & Cosponsors: The conference was sponsored jointly by the AFOSR, the Scientific Directory of the American Psychological Association, the University of California Irvine Office of Research and the University of California Irvine School of Social Sciences. It was also co-sponsored by the UC Irvine Department of Cognitive Sciences, the UC Irvine Institute for Mathematical Behavioral Sciences, and the Society for Mathematical Psychology.

Attendees: The total conference attendance (registered attendees) was 85. This included 23 speakers, 42 research and general attendees, plus 20 student attendees. These included attendees affiliated with UCLA, UCSD, USC, University of Washington, Oregon State University, Columbia, Stanford etc., as well as a number of participants from the local community. Meals/snacks were provided on-site due to the tight scheduling. The speakers included many internationally recognized speakers in their fields, including six members of the National Academy of Sciences or the American Academy of Sciences (Luce, Suppes, Graham, Loftus, Shiffrin, Albright), and many elected members of the Society for Experimental Psychology. The attendees similarly included many highly recognized members of the field and a good cohort of students.

We were fortunate in coordination of this conference with the meeting of the Society for Mathematical Psychology. The attendance by students was encouraged by a subsidized attendance/meal fee.

Program Details: The conference **Frontiers in Human Information Processing** included four primary sessions. A copy of the conference abstract book which summarizes all of the talks is appended to the report. The list of speakers in each session appears below, followed by brief summaries of the relationships of talks in each session. The full abstracts may be found in the abstract book.

Session I: Vision

Geoff Iverson (UC Irvine) The analytic form of the daylight locus.

Joshua Solomon (City University, London) Contextual effects in contrast discrimination.

Norma Graham (Columbia University) Adaptable contrast comparison.

Charles Chubb (UC Irvine) The dimensions of preattentive visual sensitivity.

Michael Landy (NYU) Second-order spatial vision: Psychophysics, computation and brain mechanisms.

Tom Albright (Salk Institute) In your mind's eye: Neural correlates of visual associative memory.

Session II: Attention

John Reynolds (Salk Institute) Mapping the microcircuitry of attention: Attentional modulation varies across cell classes in visual area V1.

Adam Reeves (Northeastern University) Paying attention to pure tones.

Barbara Doshier (UC Irvine) Mechanisms of visual attention and perceptual learning.

Eileen Kowler (Rutgers University) Eye movements and attention.

Wilson Geisler (University of Texas, Austin) Fixation search in naturalistic backgrounds.

Session III: Memory & Cognition

Duncan Luce (UC Irvine) Behavioral axioms for utility of gambling.

Stephen Link (UC San Diego) A new psychophysics

Jean-Claude Falmagne (UC Irvine) On meaningful scientific laws on bounded domains: A theoretical analysis

Richard Shiffrin (Indiana University) How experience shapes memory.

Michel Treisman (Oxford University) Do we need a sensory memory store to explain delayed discriminations?

Stephen Grossberg (Boston University) Towards a unified theory of neocortex: From vision to cognition.

Session IV: Applications

Elizabeth Loftus (UC Irvine) What's the matter with memory?

Zhong-Lin Lu (University of Southern California) Identifying mechanisms of amblyopia.

Patrick Suppes (Stanford University) Visual processing in the brain of color and shape.

Roger Ratcliff (Ohio State University) Aging, IQ, and reaction time.

Misha Pavel (Oregon Graduate Institute) Home-based psychophysics: Unobtrusive assessment of mobility and cognitive functions.

Erich Weichselgartner (ZIPD) Scientometrics: The measurement of science illustrated by selective examples of George Sperling's Work.

The full abstracts of these talks appear in the conference abstract book (attached).
A summary of the sessions appears below:

Session Summaries:

I. Vision

The *Vision* session started with three talks by researchers who addressed fundamental coding and properties of color (G. Iverson with C. Chubb, 'The analytic form of the daylight locus') and of contrast effects on the perception of black-white contrast (J. Solomon, 'Contextual effects in contrast discrimination') and of the effects of immediate temporal adaptation on contrast perception (N. Graham, 'Adaptable contrast comparison'). This continued with two talks focusing on the coding and mechanisms of texture and related second-order stimuli that are segmented based on subtle differences in contrast or luminance distributions (C. Chubb, 'The dimensions of preattentive visual sensitivity) and the encoding of objects and patterns which are distinguished from the surround by cues in luminance, color, texture or motion (M. Landy, 'Second order spatial vision: Psychophysics, computation and brain mechanisms'), and ended with a talk on how object properties are processed in bottom up signaling and top down signaling based on responses of neurons in visual cortex (T. Albright, 'In your mind's eye: Neural correlates of visual associative memory'). These talks almost all incorporated formal analyses of the sensory inputs, and formal or computational models of visual processing, integrated with consideration of visual neural substrates of visual perception.

II. Attention

The *Attention* session provided an analysis of the role of attention in the perception of visual (auditory in one case) stimuli and the role of attention in the determination and programming of eye movements in search. The first talk focused on the alterations of neural firing patterns in early visual cortex based on attention state, and the potentially different effects of attention in distinct cell classes in area V4 (J. Reynolds, 'Mapping the microcircuitry of attention: Attentional modulation varies across cell classes in visual area V4'). The next two talks reviewed the functional and mechanistic role of attention on the perception of auditory (A. Reeves, 'Paying attention to pure tones') and visual (B. Doshier, 'Mechanisms of visual attention and perceptual learning') stimuli, especially when these stimuli are embedded in masking noise or distractors. The final two talks described the interactions of eye movements and attention. The first showed that the attention system which encodes visual objects is co-extensive with the attention system which controls voluntary movements of the eye (E. Kowler, 'Eye movements and attention'), while the second talk presented an analysis of the statistics of natural images with early information analysis and how these factors serve to choose the next location for an eye fixation in a complex scene, and compares these to computational models of optimum selection (W. Geisler, 'Fixation search in naturalistic backgrounds'). These talks, then, spanned the consideration of attention and its' importance in determining sensory processing from brain mechanisms to optimal computations, and from instructions of voluntary covert attention to the determinants of overt attention via eye movements.

III. Memory & Cognition

The *Memory and Cognition* session provided a series of examples of applications of

formal models to problems in cognition or perception. The first talk examined formal models of utility and gambling, including behavioral tests of basic axioms (D. Luce, 'Behavioral axioms for utility of gambling'). Two other talks examined the stimulus sampling theory and its relation to a wide range of psychophysical properties including Weber's law (S. Link, 'A new psychophysics') and an approach to the same problems from the perspective of meaningfulness (J.-C. Falmagne, 'On meaningful scientific laws on bounded domains: A theoretical analysis'). One talk elucidated the implications of formal models of memory systems and the implications for learning new lexical and semantic information (R. Shiffrin, 'How experience shapes memory'). Formal models of criterion setting were considered in their implications for the role of stimulus memory on sensory judgment phenomena (M. Treisman, 'Do we need a sensory memory store to explain delayed discrimination?'). Finally, an integrated neural networks model of perception and cognition was presented which detailed the related circuit designs in vision, working memory and prefrontal cortex (S. Grossberg, 'Towards a unified theory of neocortex: From vision to cognition'). This session provided an indication of the strength of formal mathematical or computational network modeling in explaining a range of sensory, perceptual, memory, and judgment phenomena.

IV. Applications

The *Applications* session presented a number of quite interesting applications of cognitive and information processing results and models to real-world applications, and a final analysis of scientific information systems. These talks started with a description of the creation and maintenance of "false memories" and applications to legal and other processes (E. Loftus, 'What's the matter with memory?'). A talk examined the role of extending theoretically derived forms of visual testing and specific training on the identification and remediation of visual processes in amblyopes, or lazy eye (Z.-L. Lu, 'Identifying mechanisms of amblyopia'). Another examined the use of EEG and other brain responses in the classification of the codes for basic object attributes, a topic which may have application for diseases in which speech and/or motor interaction is compromised (P. Suppes, 'Visual processing in the brain of color and shape'). Another presentation examined the application of theories of information processing and decision to understanding changes in processing in human aging (R. Ratcliff, 'Aging, IQ, and reaction time'), and another discussed unobtrusive home-based assessments of activity and performance, with special applications to aging populations (M. Pavel, 'Home-based psychophysics: Unobtrusive assessment of mobility and cognitive functions'). The final talk examined statistical records and impacts of science, with special focus on examples of the impact of work by Professor Sperling (E. Weichselgartner, 'Scientometrics: The measurement of science illustrated by selected examples of George Sperling's work'). This session provided strong examples of the value of development of quantitative theories, optimal task analyses, and research measures in their applications to practical issues, providing a real sense of the relationship of science and its translational applications.

Support: The conference was sponsored jointly by the AFOSR, with additional funding from the American Psychological Association, and from a number of entities at UC Irvine. The AFOSR funding was used specifically to pay for speaker's travel expenses and a small amount for organization and hosting activities including the printing of the schedule. The financial reports were provided previously.